Publisher
Sophia Publishing Group

Edited by
Editorial Team of International Journal of Marine Science
Email: edit@ijms.sophiapublisher.com
Website: http://ijms.sophiapublisher.com

Address:
11388 Stevenston Hwy,
PO Box 96016,
Richmond, V7A 5J5, British Columbia
Canada

International Journal of Marine Science (ISSN 1927-6648) is an open access, peer reviewed journal published online by BioPublisher.

The journal publishes all the latest and outstanding research articles, letters and reviews in all areas of marine science, the range of topics containing the advancement of scientific and engineering knowledge regarding the sea; from chemical and physical to biological oceanography, from estuaries and coastal waters to the open ocean; as well as including fisheries, socio-economic science, co-management, ecosystems and other topical advisory subjects.

BioPublisher, operated by Sophia Publishing Group (SPG), is an international Open Access publishing platform that publishes scientific journals in the field of life science. Sophia Publishing Group (SPG), founded in British Columbia of Canada, is a multilingual publisher.

All the articles published in International Journal of Marine Science are Open Access, and are distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

BioPublisher uses CrossCheck service to identify academic plagiarism through the world’s leading plagiarism prevention tool, iParadigms, and to protect the original authors' copyrights.
Latest Content

**Influences of Environmental Factors on Fish Assemblage in the Tropical Estuary of South West Coast of India, A Case Study of Kodungallur-Azhikode Estuary**

P.R. Jayachandran, S. Bijoy Nandan, O.K. Sreedevi, V.F. Sanu

4-16

**The Dynamic of Embankment Width Change at the Coastal Area of Pangkep District, South Sulawesi Province, Indonesia**

Andi Gusti Tantu, Ahmad Mustafa, Dahlifa, Andi Rezky Puspita Ayu

17-22

**Barrier and Platform Reefs of the Vietnamese Coast of the South China Sea**

Yuri Latypov

23-32

**Biodiesel Fuel Production from Marine Microalgae Isochrysis galbana, Pavlova lutheri, Dunaliella salina and Measurement of its Viscosity and Density**

T. Sujin Jeba Kumar, C.K. Balavigneswaran, K.P. Srinivasakumar

33-35

**Integrating Anthropogenic and Climatic Factors in the Assessment of the Caribbean Spiny Lobster (Panulirus argus) in Cuba: Implications for Fishery Management**

Rafael Puga, Roberto Piñeiro, Romina Alzugaray, Lisset Susana Cobas, María Estela de León, Ofelia Morales

36-45

**Variability in the Tropical Southwest Indian Ocean and Influence on Southern African Climate**

Mark R. Jury

46-64

**Sea Surface Warming and its Implications for Harmful Algal Blooms off Oman**

Y.V.B. Sarma, Khalid Al-Hashmi, Sharon L. Smith

65-71

**Carbon Partitioning and Allometric Relationships between Stem Diameter and Total Organic Carbon (TOC) in Plant Components of Bruguiera gymnorrhiza (L.) Lamk. And Lumnitzera racemosa Willd. in a Microtidal Basin Estuary in Sri Lanka**

K.A.R.S. Perera, M.D. Amarasinghe

72-78

**Environmental Influences on Agulhas Fish Catch**

Mark R. Jury

79-90

**Mapping the Under Water Habitat Related to their Bathymetry using Worldview-2 (wv-2) Coastal, Yellow, Rededge, Nir-2 Satellite Imagery in Gulf of Mannar to Conserve the Marine Resource**

R. Uma Maheswari

91-97

**Food and Feeding Habits of the Mudskipper, Boleophthalmus boddarti (Pallas, 1770) from Pichavaram Mangroves, Southeast Coast of India**

V. Ravi

98-104
Concentration of Polycyclic Aromatic Hydrocarbon (PAHs) in the Sediments and Milkfish (Chanos chanos, Forsk) at Marunda and Blanakan Ponds, Indonesia
Noverita Dian Takarina, Sharfina Tammy Aryanti, Mohammad Agung Nugraha
105-110

Spatial Patterns in Diversity and Distribution of Benthic Molluscs in a Weak Tidal Tropical Lagoon
R.E. Uwadiæ
111-120

Microzooplankton Grazing Impact on Phytoplankton Blooms in the Coastal Seawater of the Southern Crimea (Black Sea)
L.V. Stelmakh
121-127

Spatial and Temporal Variation of Total Nitrogen and Total Phosphorus in Major River Systems of Sundarbans Mangrove Forest, Bangladesh
S.M. Bazlur Rahaman, Md. Sharif Hasan Sohag, Alokesh Kumar Ghosh, Sudhin Kumar Biswas, Lipton Sarder, Joyanta Bir, Shahjahan Siraj Opu
128-134

Effect of Temperature and Nutrient Limitation on the Growth and Lipid Content of Three Selected Microalgae (Dunaliella tertiolecta, Nannochloropsis sp. and Scenedesmus sp.) for Biodiesel Production
Nita Rukminasari
135-144

Long-term Changes in Sea Surface Temperature at Selected Locations in the Sea of Oman and the Arabian Sea off Oman
Y.V.B. Sarma, Anesh Govender, Ebenezer S. Nyadjro, Sergey Piontkovski
145-150

Immunomodulating Properties of Bioactive Compounds Present in Aurora globostellata
K. Chairman, M. Jeyamala, S. Sankar, A. Murugan, A.J.A. Ranjit Singh
151-157

Can the Marine Ecosystem of a Posidonia oceanica Back-reef React and Defend Itself against the Spread of Caulerpa racemosa var. cylindracea?
Mauro Lenzi, Francesca Birardi, Maria Grazia Finoia
158-165

The First Record of Three Cymothoid Isopods from Red Sea Fishes, Yemeni Coastal Waters
A.B. Zubaidy, F.T. Mhaisen
166-172

Temporal and Spatial Variation of Sand Dunes, the Caspian Sea
Homayoun Khoshravan, Seidmasoumeh Banihashemi, Mahdieh Shapouri
173-177

Coastal Lagoon: Present Status and Future Challenges
Debasish Mahapatro, R.C. Panigrahy, S. Panda
178-186
Latest Content (Continued)

Conservation and Management of Tuna Fisheries in the Indian Ocean and Indian EEZ
P. Satheeshkumar, N.G.K. Pillai
187-192

Census and Phenology of Breeding Waterbirds on the Islands of Khan, Tahmadon, Om-Al-Gorm and Nakhiloo in the Persian Gulf, Iran
Behrouz Behrouzi-Rad
193-200

Levels of Organochlorines Contaminants on Fish Species from Coastal Area in the Southeastern Brazil
Aldo Pacheco Ferreira
201-211

Bioaccumulation of Pb, Cd, Cu, and Cr by Porphyridium cruentum (S.F. Gray) Nägeli
Tri Retnaningsih Soeprobowati, Riche Hariyati
212-218

Fish Distribution in Fauna Data in Lagoon of Aveiro (North Portugal): a Comparative Analysis between 1758 and the Present—An Interdisciplinary Case Study
M.R. Bastos, A. Vidal, U.M. Azeiteiro, J.A. Dias
219-224

Criteria for Incorporating the Guidelines of the Integrated Coastal Zone Management (ICZM) in Territorial Land Use Planning: Study Case for the Colombian Pacific Coastal Area
Ángela López Rodríguez, Paula Cristina Sierra Correa, Pilar Lozano-Rivera
225-237

Geochemical Fractionation of Copper (Cu), Lead (Pb), and Zinc (Zn) in Sediment and their Correlations with Concentrations in Bivalve Mollusc Anadara indica from Coastal Area of Banten Province, Indonesia
Noverita Dian Takarina, Dietriche G Bengen, Harpasis S Sanusi, Etty Riani
238-243

Construction of Scenarios: Planning and Sustainable Development in the Northern Coastal Area of Camagüey Province, Cuba
Ernesto Figueredo Castellanos, María Elena Zequeira, Pedro Morales, Mayra González, José Plasencia, Alfredo León
244-252

Caspian Rapid Sea Level Changing Impact on Estuaries Morphodynamic Deformation
Homayoun Khoshravan, Masoumeh Banisheshemi
253-257

Performance Assessment of Lokoja Confluence Beach as a Tourist Site in Kogi State, Nigeria
Samuel Oluwaseyi Olorunfemi, Emmanuel Adebayo Adewummi
258-266

Representation of Coastal Upwelling and Environmental Interactions in the Southern Benguela in Satellite Era Reanalysis
Mark R. Jury
267-277
Fishermen Community Economic Empowerment through Joint Development Business Group in Cirebon City  
Liliek Soeprijadi, Endang Yuli, Edi Susilo, Rudianto  
278-284

A Stable Isotope Study of the Relationship between Coral Tissues and Zooxanthellae in a Seasonal Tropical Environment of East Kalimantan, Indonesia  
Handoko Adi Susanto, Makoto Komoda, Masaaki Yoneda, Akihiro Kano, Mutsunori Tokeshi, Hiroko Koike  
285-294

Comparative Ultrastructural and Biochemical Studies of Four Demosponges from Gulf of Mannar, India  
Ramjee Pallela, Venkateswara Rao Janapala  
295-305

Mass Mortality of Porites Corals on Northern Persian Gulf Reefs due to Sediment-Microbial Interactions  
Javid Kavousi, Parviz Tavakoli-Kolour, Abbas Barkhordari, Arezoo Bahrami  
306-310

Waterbirds Population, Species Diversity and Similarity Fluctuation in Relation to Water Pollution in Zangi and Ahmadi Coastal Wetlands in Khore Mosa, Iran  
Behrouz Behrouzi-Rad  
311-318

Low-input Modified Extensive Shrimp Culture Systems for Penaeus monodon Restrain Vibrios  
Sheryl Oliveira Fernandes, R.A. Sreepada, Shantanu S. Kulkarni, Sheetal V. Karekar, Resha R. Shirodkar, Christian Vogelsang, P.A. Lokabharchi  
319-332

Tracking the Response of Phytoplankton following Gyttja Disturbance: a Mesocosm Field Study in Myall Lakes, New South Wales, Australia  
Nita Rukminasari  
333-343

Birds Observation and Nest Count of Crab Plover Dromas ardeola, Western Reef Heron Egretta gularis and four Tern species on Ghaber Nakhoda Island (Persian Gulf) in 2003 and 2012  
Behrouz Behrouzi-Rad  
344-351

Coupling of Shoreline Erosion and Biodiversity Loss: Examples from the Black Sea  
N.V. Shadrin  
352-360

The Aqaba Marine Protected Area—Integration of Marine Science and Resource Management in the Gulf of Aqaba-Red Sea  
Mohammad Al-Zibdah  
361-367
Latest Content (Continued)

Ecomorphological Analyses of Marine Mollusks’ Shell Thickness of *Rapana venosa* (VALENCIENNES, 1846) (Gastropoda: Muricidae)
Igor P. Bondarev

Integration as a Significance Factor in Effective Coastal Management: Egypt as a Case Study
Hossam Samir Ibrahim, Safaa A. Ghoneim

Sex Ratio Variation of the Omani Indian Oil Sardine *Sardinella longiceps* (Valenciennes, 1847)
Saud Musallam Al-Jufaili

A Review of the Green Mussel *Perna viridis* Fishery of South West Coast of India
P. Laxmilatha
A Review of the Green Mussel *Perna viridis* Fishery of South West Coast of India

P. Laxmilatha
Central Marine Fisheries Research Institute, P. B. No. 1603, Ernakulam North P.O., Cochin 682 018, Kerala, India
Corresponding author email: laxmil@yahoo.com

Abstract
The green mussel, *Perna viridis* (Linnaeus1758) (Bivalvia, Mytilidae) is a commercially important species in India. Estimated total production from the mussel beds along the Malabar Coast during 1996-2008 was 89,593 t and the average annual production was 7,466 t. Among the eight major mussel landing centres, Chaliyam recorded the highest production during 2003-2008 followed by Thalasseri / Thalayi and Moodadi / Thikkodi (19%), and Elathur / Kollam (9%). The CPUE was highest for Koduvally, followed by Chaliyam. The average price per 100 Kg shell-on mussel during 1996-2008 was € 9.9 (INR 617). This fishery sustains the livelihood of 1,551 mussel pickers along the South West Coast. The fishery is dependent on the wild recruitment of spat fall whose annual density is influenced by the southwest monsoon. The distribution, fishery and management of this fishery along the south west coast of India are described.

Keywords
Green mussel; *Perna viridis*; Fishery; Management

Introduction
India has two species of mussels, the green mussel, *Perna viridis* and the brown mussel, *Perna indica*. *P. viridis* is more widely distributed compared to the brown mussel. Green mussels are found along the intertidal coasts of Quilon, Alleppey, Kochi, Kozhikode (Calicut), Kannur and Kasargod districts of Kerala, a state on the south west coast of India. It is most abundant from Kozhikode – Kannur to Kasargod which is known as the mussel zone of India (Kuriakose et al., 1984) (Figure 1). Along the east coast of India, it ranges along Chilka Lake (Orissa), Vishakapatnam (Andhra Pradesh), Chennai (Tamil Nadu), and Cuddalore (Pondicherry). It is also found along Mangalore, Karwar, Goa, Ratnagiri, and in the Gulf of Kutch and the Andamans and Nicobar Islands (Jones and Alagarswami, 1973).

Bivalve exploitation plays an important role in the national economy of many countries (Vakily, 1992). Although limited in its geographical distribution, the green mussel has been of potential interest to several investigators. The genus *Perna* has been described by...
Chatterji et al. (1984), Vakily (1989, 1992), Alfaro (2006a, b) and Laxmilatha and Sivadasan (2007a, b).

The culture potential of the green mussel has been extensively investigated by Choo(1974), Qasim et al. (1977), Parulekar et al. (1982), Chatterji et al. (1984), Coeroli et al. (1984), Kuriakose et al. (1988), Appukuttan et al. (1998) and Laxmilatha et al. (1996, 2001, 2009). Induced spawning, egg and larval development and spat production in hatchery have been carried out by Tan (1975), and Laxmilatha et al. (2011). Earlier reports on the green mussel fishery, biology and spat settlement are by Kuriakose et al. (1984), Selvaraj (1988), Appukuttan et al. (2001), Thomas et al. (2002) and Laxmilatha and Sivadasan (2007a).

Reproductive behavior of the green lipped mussel *P. canaliculus* has been described by Buchanan (2001) and Alfaro et al. (2001, 2003). Settlement and recruitment patterns in *Mytilus galloprovincialis* and *M. canaliculus* have been detailed by Peteiro et al. (2007) and Phillips (2007). Small scale settlement pattern, spatial variability in reproductive behavior, spatial and temporal variability in density and distribution of mussel larvae and spat have been described by Alfaro and Jeffs (2002), Alfaro et al. (2004), Erlandsson et al. (2005) and Porri et al. (2006 a, b, 2008).

However, the unique green mussel fishery of India has not been described in detail earlier although it has existed for decades. A review of the special features of the green mussel fishery along the south west coast of India, the spat settlement pattern, its increasing significance to the rapidly expanding mussel farming sector, and present and future management perspectives are presented.

1 Materials and Methods

The major green mussel beds along the South west coast are South beach, Chaliyam, Elathur, Kollam, Moodadi, Thikkodi, Chombala, Mahe, Thalasseri, Thalayi, Koduvally, Kadali, Thalassery, Thalayi, Chembarica, Kottikulum, and Bekal. The mussels are landed at eight major centers viz., South beach / Chaliyam, Elathur / Kollam, Moodadi/Thikkodi, Mahe, Thalassery/Thalai, Chombala Koduvally, Kadali. The mussel landings data from the eight centers were collected at weekly intervals, by recording the number of canoes / “catamarans” (made by tying up 3 wooden logs) and number of mussel pickers. Usually 2-3 pickers go out in a small canoe/catamaran and return with their individual collection of mussels tied in a nylon bag around their waist or heaped in the canoe. Each picker was considered as a single unit and the catch per unit effort (CPUE) is the catch landed per mussel picker in kilograms. The monthly landings from the canoes operated at each center were raised and the annual mussel production was estimated. The catch effort data of the green mussel landings at the eight major landing centers was estimated from 2003 to 2008. The monthly and annual trends in production were analyzed for the major centers. The catch data and price structure for the green mussel for the period 1996-2002 was collected from the annual reports of Central Marine Fisheries Research Institute (CMFRI Annual reports 1995-2002) for analyzing the fishery trend during the entire period from 1996-2008.

2 Results

2.1 Mussel beds

The major mussel beds along the South west coast are distributed across three districts of Kerala and in Mahe (Union Territory of Pondicherry) (Figure 1 and Figure 2 A–H). The mussel beds in Kozhikode (Calicut) district are Chombala, Thikkodi, Moodadi, Kollam, Elathur, South beach and Chaliyam, constituting about 435 ha. Mussel bed off Mahe (Pondicherry) constitutes nearly 20 ha. The major mussel beds in Kannur district are along Kadalayi, Koduvally, Thalasseri and Thalayi, constituting 125 ha. In Kasargod district, the mussel beds are off Chembarica, Kottikulum, and Bekal constituting 40 ha. The total area of mussel beds along the Malabar Coast constitutes 620 ha in area. Spat settlement occurs on lateritic formations along South beach, Chaliyam, Elathur, Kollam, Moodadi and Thikkodi. Granite rocks are observed in Chembarika, Kottikulum, Bekal, Kadalayi, Koduvally, Thalasseri, Thalayi, Mahe and, Chombala.

The size range contributing to the green mussel fishery is 40-100 mm. The green mussels mature at 45 mm and they attain the size of 60-70 mm by end of one year. The mussels are in mature condition during June - August. Spat fall begins with the onset of monsoon (June-August) when breeding and spawning occurs. Spat settlement occurs during August to November, sometimes extending up to December during prolonged monsoon.
2.2 The green mussel fishery

The green mussel fishery along the Malabar Coast is an activity independent of the other marine fishery activities of the coast. The mussel pickers are an exclusive coastal community engaged in the exploitation of this sessile resource and 1551 persons are involved in mussel picking. The green mussel fishery begins from mid August or September onwards and lasts up to mid June. The fishery stops during the South West monsoon (June -August). Mussel picking usually begins in the early hours from 07 00 hours and last for 4-5 hours. Picking is generally done during low tide, on bright sunny days when the water is clear. Pickers dive down to the mussel beds and use chisel or knife to scrape off the mussels from the intertidal rocks. The depth ranges from 0.5 to 10 m. The pickers stock the picked mussels in nylon bags tied around their waists (Figure 3: A). In most centers, the 2-3 pickers go out in a small canoe and return with their individual collection heaped in the canoe, while in Thikkodi, the pickers use “catamarans” (made by tying up 3 wooden logs) to reach the mussel beds (Figure 3: A). The fishing duration varies depending on the demand for the mussel and the availability of the particular size range. The size of the mussels contributing to the fishery ranges from 50-100 mm. Each picker harvests about 65 Kg, known as one “Maal” / day (Figure 3: A, B). The mussels are then auctioned to the local agents. A gunny bag of picked mussel contains nearly 100-120 Kg, which fetches INR 700 - 1100 (€ 11.38-17.89) during the peak season. In the local market, about 80 mm size mussels are sold at INR 80/- (€ 1.30) per 100 mussels. The price varies with size of the mussels and availability of other food fishes.

The special feature of the green mussel fishery of Malabar is the exclusive spread / distribution of the mussel beds along the coast of North Kerala, West coast of India. It extends from Kozhikode (Calicut) to
Kasargod and therefore forms the “Green mussel zone of India”. Mussel pickers form an exclusive coastal community, who are not organized but sustain the fishery through self imposed closure of the fishery during the monsoon months. The green mussel contributes to the cuisine of North Kerala and fetches revenue of € 90,885 (INR 56, 34,870/-) annually, contributing to the total marine fish production.

The estimated total production of the green mussel along the Malabar Coast during the period 1996-2008 was 89,593 t (Figure 4). The average annual production was 7,466 t. The total effort was 15,83,639 (man days) and the average annual catch per mussel picker was 56.6 Kg. The highest production was recorded during 2006 at 14,835 t and the total effort expended was 23,325 (man days). The CPUE was 63.6 Kg. The lowest production was recorded during 1998 at 3,408 t although the effort was high at 71051. The CPUE was 48 Kg. The effort has been increasing over the years especially since 2006. The year 2006 registered the highest effort (233,257) and also significant increase in production (41.4%) over the previous year. This was probably due to intense spat settlement during 2005 and increased demand for the mussels. Chaliyam, Thalasseri/Thalayi, Moodadi/Thikkodi and Elathur / Kollam were the major centers of mussel landings (Figure 5).

The green mussel landings from the major landing

![Figure 4 Trend of annual catch and effort of *Perna viridis* during 1996-2008](image-url)
centers have been analyzed in detail for 2003-2008. The estimated total production of the green mussel from the mussel beds along the Malabar Coast, during that period was 54,306 t. The average annual production was 6788 t. The total effort was 994,363 (man days) and the average annual catch per unit effort (CPUE) was 54.6 Kg. The highest production was recorded during 2006 at 14835 t and the total effort expended was 233257. The CPUE was 63.6 Kg per month / picker. The lowest production was recorded during 2008 at 5172 t. The CPUE was 48 Kg. The average monthly production from the mussel beds during 2003-2008 was highest during November at 12810 t and CPUE of 63.8 Kg. The lowest average monthly production was recorded during July at 176 t and CPUE 46.8 Kg (Figure 6).

Figure 6 Average monthly landings of *P. viridis* during 2003-2008

Among the eight major mussel landing centres, Chaliyam recorded the highest production (28%) during 2003-2008 followed by Thalasseri/Thalayi and Moodadi/Thikkodi (19%) and Elathur/Kollam (9%) (Table 1). Effort was also highest at Chaliyam (24%) followed by Thalasseri/Thalayi (20%), Moodadi/Thikkodi (18%). The CPUE was highest for Koduvally (71 Kg) followed by Chaliyam (63 Kg).

2.3 Green mussel fishery of major centers

The catch effort details of green mussel landings at the eight major centers are given in Table 1.

**Chaliyam**: The average monthly production during 2003-2008 was highest during November at 388 t and lowest in August at 20.5 t. The CPUE was highest during May at 79.2 Kg. Highest effort was expended during November.

**Elathur / Kollam**: The average monthly production during 2003-2008 was highest during October at 122 t and lowest in July at 4.7 t. The CPUE was highest during September at 49 Kg. Highest effort expended was highest during October.

**Moodadi / Thikkodi**: The average monthly production during 2003-2008 was highest during January at 350 t and the lowest in June at 8.6 t. The CPUE was highest during August 62.5 Kg. Highest effort was expended during October.

**Chombala**: The average monthly production during 2003-2008 was highest during April at 306 t and lowest in August at 5.4 t. The CPUE was highest during October at 50 Kg. Highest effort was highest during November.

**Mahe**: The average monthly production during 2003-2008 was highest during October 88 t and lowest in June at 17 t. The CPUE was highest during August at 66.5 Kg. Highest effort was expended during October.

**Thalasseri / Thalayi**: The average monthly production during 2003-2008 was highest during November at 249 t and lowest in June at 35 t. The CPUE was highest during November at 75.8 Kg. Highest effort was expended during October.

**Koduvally**: The average monthly production during 2003-2008 was highest during April at 135 t and lowest in July at 1.5 t. The CPUE was highest during April at 168.2 Kg. Highest effort was expended during November.

**Kadalayi**: The average monthly production during 2002-2008 was highest during March at 87 t and lowest in June at 3.7 t. The CPUE was highest during January.

2.4 Price structure

The fresh mussels are sold locally; usually shell-on by
numbers or weight. The mussels are brought to the local fish markets in gunny bags or plastic crates by local transport (bicycles/auto rickshaws). Cycles loads of mussels are also taken to interior areas for direct marketing in residential areas. In some areas, shucked meat is also sold. In whole of North Kerala, mussel meat is considered a delicacy and is part of the cuisine for all festive occasions. The mussel meat is consumed without depurating. Mussels form an important item in the daily menu in most households of North Kerala. The fresh mussel meat is prepared in various traditional forms and delicacies like ‘ari kaduka’ (rice mussel), mussel stew, and mussel fried rice and mussel biriyani. Processed products such as dried and smoked mussel meat, marinated mussel meat, mussel meat pickle, mussel meat chutney powder, canned mussel meat and ready-to-serve fried mussel meat are also available in the market. The shell finds limited use in the lime industry.

The price of the picked mussels depends upon the size, demand, season and non-availability of other food fishes. The average price for 100 Kg of shell-on mussels during 1996-2008 was € 9.9 (INR 617). The average price of 100 Kg of shell-on green mussel ranged from € 5.89 (INR 365) in 1996 to a high of € 17.83 (INR 1107) in 2008 (Figure 7). The highest price 100 Kg shell-on mussel was recorded during 2008 at € 21.37 (INR 1325) at Moodadi / Thikkodi landing centre and lowest in 1996 at € 3.6 (INR 223) at Mahe landing centre. The highest average price for 100 Kg shell mussel was recorded for Kadalayi landing centre at € 10.9 (INR 674). However, Kadalayi became a major landing centre since 2002 only. In 2008, the mussel price increased due to high demand but low production and the highest average price was recorded at Moodadi / Thikkodi landing centre at € 21.37 (INR 1325) and the lowest at Chombala landing centre at € 9.56 ($ 593). Over the years, the price of green mussel has increased tremendously due to increase in demand.

3 Discussion
The green mussel is the only commercially important marine bivalve that forms a significant fishery in the Malabar Coast. Its extensive distribution from Bekal in Kasargod district down to South Beach in Calicut district makes it very unique and is therefore, known as the “green mussel zone of India”. The green mussel fishery is self regulated. The mussel pickers stop mussel picking for 45 days during the South West Monsoon that prevails from May to July but sometimes extends up to September. It is difficult to dive and pick mussels during this season due to the turbulence and strong currents. The spawning and spat settlement also takes place during the monsoon season. The pickers resume mussel picking in mid August. The peak mussel landings occur during the post monsoon season (September to May) after the self imposed control on mussel picking during the monsoon months (Kuriakose et al., 1984; Laxmilatha and Sivadasan, 2007a).

The only estimate of green mussel production has been given by Kuriakose et al. (1988). They estimated the production, total effort (man days) and catch per unit effort for the green mussel for the years 1981-1984 at 8,715 t, 169969 and 551.7 Kg. respectively The average annual production was 2405 t (Kuriakose et al., 1988). The production has thus increased by 90% over the 20 year period. Effort also has increased by 89%. Moodadi-Thikkodi centre has traditionally been the most important landing centre (Kuriakose et al., 1988). The number of mussel pickers reported as 325 during 1981-1984 has now increased to 1551. This has been due to increased awareness and consumption of mussels and increased income generated as a result of increased demand for the green mussel. The annual production of *P. viridis* during the 13-year period was consistent except for the steep increase during 2006. This was in consonance with the regular and steady settlement of spat along the coast and consequent recruitment to the fishery. The spat settlement intensity and pattern of green mussel is influenced by the annual rainfall (Laxmilatha and Sivadasan, 2007a). The spawning cycles are dependent on the onset of the SW monsoon. In *P. viridis*, major spawning occurs during June to
September with settlement from August to December. Spatial variation in size specific reproductive output could also have important consequences for recruitment as has been described for *P. canaliculus* and *M. californianus* (Alfaro et al., 2003; Phillips, 2007). Settlement occurs at low intensities throughout the year and intense settlement occurs during post monsoon (Kuriakose et al., 1984; Hunt and Scheibling, 1996).

The green mussel is also a favored candidate for farming and has been very well domesticated in the estuaries of Malabar. Mussel farming is carried out in estuaries when high saline conditions prevail from October to April. Suspended rope culture on racks is most popular but in certain low, intertidal areas, bottom culture is also practiced (Kuriakose et al., 1988; Appukuttan et al., 1998; Laxmilatha et al., 2001; Laxmilatha et al., 2009). The estimated mussel seed biomass during November 2006 was 4541 t from Kozhikode, Kannur and Mahe. Assuming that about 15% of the estimated total is used for seeding for mussel culture in the estuaries in Malabar, 681 tones of seed would be available for farming. The total length of rope that can be seeded with this quantity of seed would be 2,72,400 m, at the rate of 2.5 Kg seed per meter of rope. About 2724 farmers can do mussel farming at the rate of 100 m of seeded rope per farmer. Over 2000 farmers are expected to set up mussel farms in the next few years in Padanne, Dharmadom, Valapattanam, Mahe, Korapuzha, Kadalundi, Chaliyar and Moorad estuaries. Given this scenario, although spat settlement is highly variable from year to year, there is sufficient quantity of seed that can be used for farming. Farming in most estuaries in Malabar can be done only by December end / January when higher salinity levels suitable for farming prevail. Thus farmers faced acute shortage of seed supply for farming during 2006. This has also led to exorbitant prices for the seed (€ 0.16 / Kg). The farmers are switching over to on-bottom culture instead of the suspended (rack) culture by stocking large sized mussels (60–70 mm, retarded mussels of previous years’ settlement) which fail to attach to ropes causing significant loss due to high rate of slippage. The mussel farming sector now faces two-fold problem in acquiring seed for farming in the estuaries. Mussel spat settlement has been highly variable and not available during the mussel farming season. The mussel pickers are unwilling to supply seed to the mussel farmers. They sort the seed picked along with adults and put it back in the mussel beds. These factors have caused severe pressure on the mussel farmers due to non-availability of adequate quantities of seed for seeding (Laxmilatha and Sivadasan, 2007b; Laxmilatha et al., 2009).

In conclusion, the green mussel fishery of the South west Coast of India has unique features which contribute to the sustainability of the fishery. The increased demand for green mussel in recent years has led to increased effort and exploitation of the green mussels. However, the fishery is self managed and sustained by the mussel pickers themselves by suspending fishing during monsoon season. The special topographic distribution of the mussel beds and the interactions of the climatic factors sustain the livelihood of several wild mussel harvesters in the region.

**Acknowledgements**

The author is thankful to the Director, Central Marine Fisheries Research Institute, Cochin for support in carrying out this work. The assistance rendered by V. G. Surendranathan and M. P. Sivadasan in collecting the green mussel catch and effort data from the green mussel landing centers is appreciated and acknowledged.

**References**


http://dx.doi.org/10.1016/j.jembe.2006.07.004


http://dx.doi.org/10.1016/j.aquaculture.2004.07.029


http://dx.doi.org/10.1071/MB03007


Buchanan S., 2001, Measuring reproductive condition in the green shell mussel *Perna canaliculus* New Zealand. Journal Marine and
Freshwater Research, 35:859-870
http://dx.doi.org/10.1080/00228353.2001.9517048
http://dx.doi.org/10.1016/0044-8486(84)90215-1
Coeroli M., Gaillande D., Landret J.P., and AQUACOP, 1984, Recent innovations in cultivations of molluscs in French Polynesia, Aquaculture, 39: 45-67
http://dx.doi.org/10.1016/0044-8486(84)90058-8
http://dx.doi.org/10.1016/j.jembe.2004.09.010
http://dx.doi.org/10.1016/0176-8382(93)90133-Q
http://dx.doi.org/10.1016/j.aquaculture.2010.12.031
http://dx.doi.org/10.1016/0044-8486(82)90035-7
http://dx.doi.org/10.3354/meps315141
http://dx.doi.org/10.1016/j.jembe.2005.11.008
http://dx.doi.org/10.1016/j.jembe.2008.09.026
http://dx.doi.org/10.1007/BF00300311
Tan W.M., 1975, Egg and larval development in the green mussel Mytilus edulis L. Cultivation on ropes from floating rafts, Indian Journal of Marine Science, 4: 189-197
Vakily J.M., 1992, Determination and comparison of bivalve growth with emphasis on Thailand and other tropical areas, ICLARM Technical report 36, pp. 125
http://ijms.sophiapublisher.com
<table>
<thead>
<tr>
<th>Year</th>
<th>Chaliyam</th>
<th>Moodadi/Thikkodi</th>
<th>Thalassery/Thalayi</th>
<th>Koduvally</th>
<th>Elathur/Kollam</th>
<th>Chombala</th>
<th>Mahe</th>
<th>Kaldalai</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Catch</td>
<td>Effort (t)</td>
<td>CPUE (Kg)</td>
<td>Catch</td>
<td>Effort (t)</td>
<td>CPUE (Kg)</td>
<td>Catch</td>
<td>Effort (t)</td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1933.9</td>
<td>31930</td>
<td>60.6</td>
<td>945.3</td>
<td>18080</td>
<td>52.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>1217.2</td>
<td>47.7</td>
<td>752.2</td>
<td>20646</td>
<td>36.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>2126.1</td>
<td>70.7</td>
<td>936.5</td>
<td>17725</td>
<td>52.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>3928.7</td>
<td>74.4</td>
<td>3799.8</td>
<td>55694</td>
<td>68.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>3759.4</td>
<td>64.8</td>
<td>2989.1</td>
<td>44185</td>
<td>67.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2008</td>
<td>2157.2</td>
<td>50.1</td>
<td>903.7</td>
<td>21308</td>
<td>42.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15122</td>
<td>241406</td>
<td>10327</td>
<td>10080</td>
<td>197212</td>
<td>3398</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>2520</td>
<td>40234</td>
<td>1721</td>
<td>29606</td>
<td>53.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Reasons to publish in BioPublisher

A BioScience Publishing Platform

★ Peer review quickly and professionally
☆ Publish online immediately upon acceptance
★ Deposit permanently and track easily
☆ Access free and open around the world
★ Disseminate multilingual available

Submit your manuscript at: http://bio.sophiapublisher.com